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Treatment of Saline Water by Solar Nano Photocatalysis

Shaik Feroz

Caledonian College of Engineering, Seeb, Sultanate of Oman

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Corresponding author: Shaik Feroz

feroz@caledonian.edu.om

Caledonian College of Engineering, Seeb, Sultanate of Oman.

Tel: 00968-92575134

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Shortage of drinking water in most parts of the world has been a growing concern in recent times. The situation has been getting worse in underdeveloped and developing countries due to sudden explosion in population growth and the growth in the industries. The natural resources for potable water are limited and unless a feasible solution is obtained in the near future, the 'concern situation' may turn into a 'panic situation'. The current solution for the shortage in drinking water is to use water from inexhaustible sources such as oceans and seas and make it potable using desalination process.

Saline water may be purified by a number of desalination techniques in which the dissolved impurities are removed from water or, more correctly, pure water is removed from saline water. The desalination of water can be achieved by a variety of techniques *viz* thermal; crystallization; solar evaporation; ion exchange; membrane separation, etc. Reverse osmosis is the reversal of the natural flow due to osmosis, in which the natural osmotic flow is reversed; water from the salt solution is forced through the membrane in the opposite direction by the application of pressure. Seawater reverse osmosis desalination has become cost effective compared to thermal desalination due to recent developments in membrane technology and pressure exchangers. However, its application has some challenges with respect to the fouling of membranes by the organic contents of shallow seawater feeds.

Pre-treatment process is needed to remove substances from feed water that would interfere with the desalting process. Suspended solids and other particles in the feed water must be removed to reduce fouling of the membranes. All membranes lose their performance with time due to fouling. One of the major causes for the loss of performance is due to the substances that get deposited on the membrane surface. Fouling of membranes is due to the suspended or emulsified materials that may be present in the feed water. Examples of such materials are silica, oil, clay, iron, sulfur and humic acids, which can be present in a very fine or colloidal form. Even the typical 5 micron cartridge filters used in the upstream of a reverse osmosis system may not completely remove these foulants. Surface water contains high-molecular weight organic matter (humic substances), suspended solids, bacteria and algae, and volatile halogenated carbons, etc. As these substances are traditionally considered hazardous for the membrane, they should be removed from the feed water before they enter the membrane systems.

Solar energy is abundant in Middle East countries like Oman and it can be effectively used in reverse osmosis pre-treatment processes. An ultraviolet driven photocatalytic pre-treatment can be employed for the degradation of humic substances (higher molecular organics) & microorganisms present in the feed water. The energy generated from the photo catalytic reaction breaks down the humic substances and also kills microorganisms, thereby eliminating the primary source for membrane fouling. UV photo-oxidation uses ultraviolet light to activate a catalyst to physically decompose the organic matter into non-toxic components. The degradation of organic compounds in the presence of UV light is too slow process (reaction rates are slow) to be considered for large scale industrial applications. To en hance the reaction rates, several catalysts such as hydrogen peroxide, ozone, Fe (II), titanium dioxide etc., are used in these types of reactions. Titanium dioxide is probably the best choice due to its low cost, low toxicity, resistance to photo-corrosion and catalytic efficiency. However the emphasis is on developing new generation photocatalysts, which should be highly active in visible region. Nano photocatalysts will be having larger surface area for reactants contact and lower time requirement for the carrier diffusing out of photocatalyst pores to the photocatalyst surface.

Extensive research work has been performed at various research centers/institutions on the application of solar photocatalysis to the treatment of pollutants in industrial wastewater. Despite its obvious potential for the detoxification of polluted water, there has been very little commercial or industrial use of solar photocatalysis as a technology so far. Although photocatalysis has been extensively applied to the treatment of industrial wastewater, very few researchers have actually tried this technique for saline water because seawater consists of a complex mixture and there is also the danger of chloride ion interference.